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# Development and psychometric appraisal of Head Nurse Research Leadership Scale

Yuanli Guo | Keke Ma | Lina Guo | Xiaofang Dong | Caixia Yang | Min Wang | Huanhuan Gao | Peihua Lv

the First Affiliated Hospital of Zhengzhou University, Zhengzhou, China

**Correspondence**
Keke Ma, Neurology of the First Affiliated Hospital of Zhengzhou University, 1st Eastern Road Jianshe Road, Erqi District, Zhengzhou, Henan, China.
Email: 809643627@qq.com

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## Abstract

**Aim:** To develop a Head Nurse Research Leadership Scale and evaluate its reliability and validity.

**Design:** A psychometric instrument validation study was conducted in two phases.

**Methods:** The item tool was generated based on a literature review, semi-structured interview and brainstorming. Twenty experts validated the content of the initial version for two rounds. Thirty-nine clinical nurses conducted the HNRLS-v3 to test the readability of the items in pilot study I. Items were screened based on the critical ratio, correlation coefficient analysis, Cronbach's α coefficient and factor analysis using the data collected from 265 nurses in pilot study II. A cross-sectional survey was conducted in six hospitals to evaluate the reliability and validity between 4 January 2022 and 15 January 2022. Three hundred and sixteen nurses participated in this survey, and 60 completed the questionnaire to validate the test–retest reliability between 1 February and 6 February.

**Results:** A 15-item Head Nurse Research Leadership Scale based on 5 dimensions was developed, and the content validity was satisfied. The 15 items accounted for 77.9% of the variance. Confirmatory factor analysis showed acceptable convergent validity and discriminant validity. The Cronbach's α coefficient, split-half reliability and test–retest reliability of the scale were 0.966, 0.9633 and 0.927, respectively.

KEYWORDS
head nurse, instrument development, leadership, research, validation study

## 1 | INTRODUCTION

### 1.1 | Potentiality and obstacles for clinical nurses to carry out nursing research

Nursing research is defined as the development of new systems of care and the application of evidence in nursing practice by the Nursing and Midwifery Board of Australia and the Nursing and Midwifery Board of Ireland (ANMBI, 2014; hÉireann, 2017), representing the foundation of nursing practice improvement. Nurses are often the first to identify and solve patient problems, given their proximity (Hughes, 2006). Thus, they are expected to become clinical experts and participate in nursing research to explore new ways to enhance care quality and patient outcomes (Curtis et al., 2017;

Lal, 2021; Powers, 2020). Although many nurses are willing, they are not quite ready to conduct nursing research due to the lack of enthusiasm, poor support from superiors, poor research skills and unavailable time (González-García et al., 2020; Henshall et al., 2020; Nowlin et al., 2021; Zhang et al., 2020), and reinforcement of leadership is regarded as the first step to improve the current situation (González-García et al., 2020; Powers, 2020). A leader with sufficient knowledge and the ability to supply the structure to support and mentor the implementation of the research process and empower nurses is essential to promoting nursing research (Berger & Polivka, 2015).

### 1.2 | The important role of head nurses in clinical nursing research

It is well-established that the nursing leadership style is closely related to nursing research or innovative behaviour. For example, leaders with entrepreneurial leadership foster nurses to be more innovative at work, especially for idea exploration, generation, implementation and championing (Bagheri & Akbari, 2018). Low research leadership results in the absence of nursing research and healthcare reforms since nurses always carry out what their leaders expect (Asuquo, 2019). Normally, head nurse (also called as 'charge nurse', a shift leader whose role includes managing nursing resources and facilitating appropriate patient flow and care in one or more nursing units; Wolf et al., 2022) decides the nurses' time allocation, and their cognition of nursing research determines the development of a nurse's research career. For instance, if all nurses hired by the head nurse participate in patient care, nurses with a higher educational background would spend more time and energy on clinical nursing work than on research (van Dongen & Hafsteinsdóttir, 2021). Besides, the influence of the head nurses was not limited to a nurse who generated research, all of the clinical nurses could be affected to think about whether to participate and cooperate in the research generation and implementation, which reflected the influence of leadership on nursing research culture (González-García et al., 2020). Overall, nursing research leadership plays an important role in all steps of clinical nursing research.

### 1.3 | The particularity and importance of 'nursing research leadership'

A person with strong leadership skills can effectively influence and engage staff in achieving common goals (Cummings et al., 2018). However, the definition of 'nursing research leadership' was not found in a literature review, while similar terms to 'research leadership' have been used in related studies, termed by some researchers as 'leadership in nursing research' (Asuquo, 2019; Australia and the Nursing and Midwifery Board of Ireland, 2014; González-García et al., 2020). It should be emphasized that huge differences exist between leadership in nursing research and daily nursing management. In this respect, daily nursing leadership can help nurses improve during patient care, including medical error reduction and prevention, enhanced patient outcomes, less work pressure and more job satisfaction (Boamah et al., 2018; Cummings et al., 2018). However, head nurses with nursing research leadership often have to lead nurses to start from scratch, including stimulating research thinking and enthusiasm, designing the research framework, conducting the research and implementing clinical transition based on available evidence. These factors are not defined by any existing rules and regulations, and leaders have to establish novel approaches to implement research leadership. Thus, a specific tool is warranted to evaluate the above abilities and characteristics to further explore nursing research leadership.

## 2 | BACKGROUND

### 2.1 | Lack of measurement tools hinders in-depth research on leadership

By conducting a literature review, we found several potential tools to assess the nursing research leadership of head nurses. One of them was the ENTRELEAD scale (Renko et al., 2015), developed to evaluate the entrepreneurial leadership of leaders in an organization. However, it was not specific for assessing the leadership perceived by clinical nurses from head nurses on research because the influence on the main barriers of conducting clinical nursing research of head nurses could not be fully measured. We also reviewed several universal nursing leadership scales, such as the Clinical Leadership Scale (CLS; Quan et al., 2021), the Head nurse transformational leadership self-rating scale (Hui et al., 2020) and the Authentic Leadership Self-Assessment Questionnaire (Panczyk et al., 2019). However, few items were included in these scales to measure the research leadership of nursing leaders. The most promising scale for assessing the nursing research leadership was the Implementation Leadership Scale (ILS; Aarons et al., 2014), which was abandoned since it is limited to assessing the evidence-based nursing leadership. Leadership influence on nursing research could not be measured using ILS, including the influence on the proposal of research problems, design and research scheme. Thus, a scale for measuring nursing research leadership during the whole clinical research process is warranted, rather than only for evidence-based implementation.

### 2.2 | Theoretical framework

This study generated the initial items from 5 dimensions based on the '5-force model of leadership' put forward by the research group of 'science and technology leadership' of the Chinese Academy of Sciences (2006f). The 5-force model of leadership emphasizes five important elements of leadership: foresight, influence, inspiring, decisiveness and control, with their specific meanings explained in 5 articles (Research Group of Science and Technology Leadership of the Chinese Academy of Sciences, 2006a, 2006b, 2006c,

2006d, 2006e). 'Foresight' is the ability to predict what is likely to happen and prepare for the future. 'Influence' is a leader's ability to affect the thought and behaviour of the staff. 'Inspiring' is the ability to arouse excitement, strong interest and enthusiasm in something by the staff. 'Decisiveness' is the ability to make quick decisions in a complicated situation. 'Control' is the ability to effectively grasp the organization's development direction, strategy implementation process and effectiveness. All researchers in this study learned the 5-force model of leadership before this research started.

## 3 | THE STUDY

### 3.1 | Aims

This study aimed to develop a scale to evaluate the research leadership of head nurses and its reliability and validity.

### 3.2 | Method

This study consisted of 3 phases. During phase 1, the initial version of the Head Nurse Research Leadership Scale (HNRLS) of 28 items was generated, and the content validity was evaluated. In phase 2, 15 items were screened using the critical ratio method, correlation coefficient analysis, Cronbach's α coefficient analysis and factor analysis. In phase 3, a cross-sectional survey was conducted to validate the reliability and validity.

#### 3.2.1 | Phase I: Conceptualization and initial items generation

*Conceptualization*

First, the 5 dimensions of the HNRLS were determined to be foresight, influence, inspiring, decisiveness and control according to the '5-force model of leadership' (Research Group of Science and Technology Leadership of the Chinese Academy of Sciences, 2006f), and the specific connotation of the 5 forces in the scope of nursing research leadership was discussed by the research group of this study based on literature review. A consensus was reached after 2 research group meetings—A head nurse with 'foresightedness' in nursing research should recognize the importance of nursing research, be aware of research trends and make efforts to participate in the care reform (Research Group of Science and Technology Leadership of the Chinese Academy of Sciences, 2006c). A head nurse with 'influence' in nursing research should be able to influence the thinking and behaviour of nurses in undertaking research, what to study and how to promote the smooth implementation of the project (Research Group of Science and Technology Leadership of the Chinese Academy of Sciences, 2006d). An 'inspiring' head nurse should have a strong business ability and personality charm in nursing research to encourage and attract nurses to participate in the nursing research voluntarily (Research Group of Science and Technology Leadership of the Chinese Academy of Sciences, 2006e). A 'decisive' head nurse should be able to make quick decisions in difficult situations during clinical nursing research, including time and staff arrangement and resource acquisition and allocation (Research Group of Science and Technology Leadership of the Chinese Academy of Sciences, 2006b). A head nurse with 'control' should be able to promote nursing research in their department, such as the research training and the establishment of a research management system (Research Group of Science and Technology Leadership of the Chinese Academy of Sciences, 2006a). During the conceptualization procedure, the potential subject of the scale was considered, and a clinical nurse-administered rather than a self-rating scale was developed.

*Item generation*

The item generation was conducted through qualitative interviews according to previous studies (Yuling et al., 2022). Based on the consensus of nursing research leadership connotation, 6 nursing leaders, 3 experts on nursing management and 5 clinical nurses were interviewed to help get a deeper understanding of research leadership. The outline of the face-to-face interviews is shown in Appendix S1. The voice data were transcribed within 24 h after the interview. Then, the research group organized a brainstorming session to generate the item pool of HNRLS based on the results of the literature review and semi-structured interview. Thirty-nine items have been generated so far (HNRLS-v1).

Two Delphi consultation rounds among 20 experts from six Chinese provinces (Henan, Hunan, Shanxi, Guangdong, Shanghai and Beijing) were conducted by e-mail for revising item pool and calculate content validity (Haonan, 2017). All experts had at least five years of management experience in hospital or nursing school and agreed to conduct two rounds of consultation. The questionnaire for consultation consisted of two parts—the item review part (part 1) and the expert information part (part 2). Each item was rated from 1 to 4 points (Fernandez-Feito et al., 2021; 1 ~ extremely inappropriate and should be deleted, 2 ~ inappropriate and should be retained after modification, 3 ~ acceptable, but appropriate modifications are needed, and 4 ~ acceptable without modification) according to the importance (Is the item important in evaluating head nurses' research leadership?), relevance (Does the item reflect a typical and core concept of nursing research leadership?) and clarity (Is the item easy to understand?). The experts were also invited to suggest the addition, deletion and revision of items. During the first round of consultation, it was suggested that 3 items should be added, 12 items removed, and a scale of 30 items was generated (HNRLS-v2). During the second consultation, it was suggested that 3 items should be merged into one. A scale of 28 items (HNRLS-v3) was generated after two rounds of consultation. Items with an average score of $<3$ and a coefficient of variation $\geq 0.25$ were deleted. Furthermore, the content validity of items in HNRLS-v3 was calculated using the results of the second expert consultation.

Pilot study I, which included 39 clinical nurses from two hospital departments, was conducted to test the readability of the items; each item was scored from 0 to 4 (strongly disagree to totally agree) by subjects. The HNRLS-v3 questionnaire was distributed to the participants, and the suggestions on item revision were collected at the end of the questionnaire. As a result, the formulation 'strongly disagree to totally agree' became a source of confusion for several items. For example, for the item '*The head nurse has been organizing training on nursing research knowledge and skills*', when 'totally agree' was chosen, it only meant that the head nurses had organized research training, but how often the training was delivered was not revealed. Given that we could not distinguish the varying degrees of efforts made by different head nurses, we revised the scoring description of the whole scale. After a group meeting among research members, a revised scoring description was proposed. The initial description 'strongly disagree to totally agree' remained for 5 items; for the item '*The head nurse has been organizing some training on nursing research knowledge and skills*', we added 'If the training was not delivered regularly, select the one with the closest total number of training in the whole year' with the following options 'once a year, once every 6 months, once every 3 months, once a month, once a week'. Descriptions for the other 22 items were revised as 'never, occasionally, sometimes, most of the time, always'.

### 3.2.2 | Phase II: Item screening

*The pilot study II*

The second pilot study for screening items was conducted in a tertiary hospital with 120 clinical departments that integrated medical treatment, teaching, scientific research, prevention, health care and rehabilitation, with more than 200 nurses holding a master's or doctoral degrees and more than 80% nurses with a bachelor's degree. The electronic questionnaire of HNRLS-v3 with 28 items was distributed to clinical nurses. Inclusion criteria: (1) registered nurses, (2) working in patient care or as a nurse researcher and (3) working experience of at least 2 years in this hospital. Exclusion criteria: (1) nurses who rotated different departments and (2) nurses transferred from other departments. Twelve clinical departments were extracted by computer-generated random numbers, and 269 nurses meeting the inclusion and exclusion criteria in the 12 departments were invited to complete the questionnaire. 98.51% ($n$ = 265) of nurses submitted the questionnaire. A questionnaire with more than 80% repetitive answers was regarded as invalid. Finally, 260 valid questionnaires were used to screen items.

*Item analysis*

The critical ratio, correlation coefficient analysis, Cronbach's α coefficient analysis and factor analysis were used to screen the items in this study (Minglong, 2010a). (1) For the critical ratio, the questionnaire scores collected from the pilot study were arranged from low to high. The F test was used to compare the average scores of each item between the first 27% and the last 27% of participants. Items with a decision value ≥3 and a statistically significant difference ($p < 0.05$) were retained. (2) Correlation coefficient: the items which significantly correlated with the scale's total score or with a correlation coefficient ≥0.4 were retained. (3) Internal consistency: an item was retained if the Cronbach's α coefficient of the total scale became smaller when deleted. (4) Factor analysis: the exploratory factor analysis (EFA) was adopted. The method of factor extraction was set as 'Principal Component', and the number of factors was 5 according to the '5-force model of leadership'. The Kaiser–Meyer–Olkin (KMO; optimal value: >0.6) and the Bartlett test of sphericity (optimal value: $p < 0.01$) were calculated to confirm that it was suitable for factor analysis. Then, the correspondence between each item and the factor (dimension) was analysed according to the factor loadings and the communalities. The item with satisfied communalities (>0.4) and good correspondence with the factor was retained (Table 1). The items with factor loading ≥0.4 were retained after the maximum variance rotation. (5) In this study, all retained items met criteria (4) and at least 2 out of criteria (1), (2) and (3). Finally, the items with poor attribution (have multiple factor loadings >0.4) were deleted according to the factor loading and professional connotation.

*Generation of HNRLS-v4*

Three items were deleted according to the results of item analysis, including 'head nurse has been paying attention to the nurturing of the research ability of nurses ($p = 0.074$ in the critical ratio analysis and the Cronbach's α coefficient became larger after deletion)', 'head nurse has been putting collective interests before personal interests in nursing research activities(the factor load was 0.452)', 'head nurse has a good relationship outside of work with nurses, such as friends, teachers and students(the factor load was 0.392)'. And 10 items were deleted because of poor attribution (more than 1 factor loading >0.4, and for which item the maximum factor loading is close to the minimum one). Finally, the HNRLS-v4 with 15 items was generated (Appendix S2).

### 3.2.3 | Phase III: Cross-sectional study for examining the reliability and validity of HNRLS-v4

*Design, setting and sample*

A cross-sectional study was conducted. Six hospitals participated in this survey, including 3 tertiary and 3 secondary hospitals. All 6 hospitals have more than one thousand beds with at least 30 clinical departments. Researchers contacted the nursing department officers of the 6 hospitals to obtain the list of clinical departments of each hospital. Three departments of each hospital were extracted using the random numbers generated by the computer, and all eligible nurses in extracted departments, according to the pilot study I criteria, were invited to participate in the survey. As recommended, the sample size was 5–10 times the number of questionnaire items (Minglong, 2010a).

**TABLE 1** Results of EFA in item analysis ($n = 316$)

| Items | Factor loadings | | | | | Communalities |
|---|---|---|---|---|---|---|
| | Factor1 | Factor2 | Factor3 | Factor4 | Factor5 | |
| A1 | 0.177 | 0.132 | **0.860**[a] | 0.143 | 0.214 | 0.854 |
| A2 | 0.355 | **0.406** | **0.750**[a] | 0.168 | 0.025 | 0.882 |
| A3 | 0.358 | 0.377 | **0.727**[a] | 0.290 | 0.023 | 0.883 |
| B1 | 0.381 | **0.743**[a] | 0.320 | 0.194 | 0.04 | 0.838 |
| B2 | 0.256 | **0.737**[a] | 0.210 | 0.366 | 0.172 | 0.818 |
| B3 | **0.417** | **0.662**[a] | 0.371 | 0.172 | 0.207 | 0.822 |
| C1 | **0.697**[a] | **0.454** | 0.334 | 0.228 | 0.172 | 0.885 |
| C2 | **0.711**[a] | **0.413** | 0.251 | 0.300 | 0.105 | 0.839 |
| C3 | **0.777**[a] | 0.324 | 0.258 | 0.141 | 0.205 | 0.837 |
| D1 | **0.846**[a] | 0.224 | 0.232 | 0.226 | 0.165 | 0.898 |
| D2 | **0.852**[a] | 0.226 | 0.234 | 0.264 | 0.186 | 0.936 |
| D3 | **0.756**[a] | 0.221 | 0.224 | 0.243 | 0.213 | 0.775 |
| E1 | **0.454** | 0.181 | 0.183 | **0.805**[a] | 0.194 | 0.958 |
| E2 | 0.350 | 0.388 | 0.356 | **0.705**[a] | 0.048 | 0.898 |
| E3 | **0.406** | 0.273 | 0.204 | **0.755**[a] | 0.261 | 0.919 |
| Eigenvalues (Rotated) | 4.694 | 2.644 | 2.327 | 2.017 | 1.309 | |
| % of Variance (Rotated) | 31.296 | 17.629 | 15.511 | 13.444 | 8.726 | |
| % of Cum. Variance (Rotated) | 31.296 | 48.925 | 64.436 | 77.879 | 86.606 | |
| KMO | 0.931 | | | | | |
| Bartlett's Test of Sphericity (Chi-Square) | 3050.46 | | | | | |
| df | 105 | | | | | |
| *p* value | <0.001 | | | | | |

*Note*: Bold font indicates that the absolute value of loading is >0.4. And 'a' represents the maximum factor loading of an item.

### *Instrument*

The questionnaire consisted of 15 items from 5 dimensions of HNRLS-v4 ('3 items per dimension'), and the general information of head nurses and nurses was evaluated, including the gender, age, position, professional title, educational background, the number of working years in clinical nursing and management (head nurse). Each item of HNRLS-v4 was rated from 0 to 4. The total score was obtained by calculating the sum score of 15 items, and the dimension score was specified as the average score of items in the dimension. The total score range of the scale was 0 to 60, and the average score range of each dimension was 0 to 4. Higher scores indicated stronger research leadership.

### *Procedure*

The researcher introduced the objective and significance to the contact persons of the 6 hospitals, and the electronic questionnaire was sent to them for distribution to each participant between 4 January 2022 and 15 January 2022. The 6 contact persons were required to send the electronic questionnaire to a responsible nurse in the 18 pilot departments but not the head nurses. The objective, content and significance were emphasized in the questionnaire as a foreword. Three hundred and twenty-five nurses from 18 departments were included, and 316 submitted the questionnaire. From 1 February to 6 February, the 6 contact persons were required to invite 10 nurses from the first survey to fill in the questionnaire and analyse the test–retest reliability, and 60 nurses participated in the second survey.

### *Data analysis*

The data analysis was conducted using the online analysis software SPSSAU 21.0 (Beijing Qingsi Technology Co., 2021). The general information of subjects was described using means and standard deviation (SD) or median for measurement data and percentage for quantitative data. Mean and SD were used to describe the scores of the total HNRLS-v4 and the five dimensions.

The reliability was validated using Cronbach's α coefficient, split-half reliability and test–retest reliability. The Cronbach's α coefficient of the total scale and each dimension were calculated, and

a value >0.7 was acceptable reliability (Eisinga et al., 2013). Split-half reliability was calculated by dividing the items of a scale or dimension into two halves to conduct further analysis (Beijing Qingsi Technology Co., 2021; Eisinga et al., 2013). Cronbach's α of the two halves, Spearman-Brown Coefficient and Guttman Split-half Coefficient were used to evaluate the split-half reliability of the total scale and each dimension. Values >0.6 were acceptable for the 3 indicators (Eisinga et al., 2013). The test–retest reliability was conducted around 2 months after the initial test. In this study, intraclass correlation coefficients were calculated using Pearson correlation analysis to identify the test–retest reliability.

The validity was assessed based on content, structural, convergent and discriminant validity (Minglong, 2010b). The content validity was validated using the content validity index (CVI) in item level (I-CVI) and scale level (S-CVI/Ave). I-CVI is the proportion of experts who scored 3 and 4 points in the total number of experts for each item. S-CVI/Ave was the average of all I-CVI. An I-CVI ≥ 0.78 was acceptable when 6 or more experts gave scores, and the S-CVI should be 0.9 or greater (Jingzheng et al., 2012). The structural validity was calculated using confirmatory factor analysis (CFA). The convergent validity (CV) and discriminant validity (DV) were evaluated using confirmatory factor analysis (CFA). Average variance extract (AVE, optimal value >0.5) and composite reliability (CR, optimal value: >0.7) were used for convergent validity analysis (Wei et al., 2016). The discriminant validity (DV) was evaluated using the correlation coefficient method. If the square root of AVE of an item was greater than the absolute value of the correlation coefficient between this item and other factors, the DV was satisfactory (Wei et al., 2016).

### 3.3 | Ethical considerations

Informed consent was obtained when the electronic questionnaire was filled. The sentence 'You acknowledge that your participation in this study is entirely voluntary by filling this questionnaire' was designed to appear before the subjects started and submitted the questionnaire. This study was approved by the ethics committee of the First Affiliated Hospital of Zhengzhou University.

## 4 | RESULTS

### 4.1 | General information and HNRLS scores

A total of 316 nurses participated in the survey for reliability and validity evaluation, including 21 males (6.6%) and 295 females (93.4%) with a mean age of 34.4 ± 6.2. Two hundred and forty-one subjects had a bachelor's degree (76.3%), and 25 (7.9%) had a master's degree. The subjects had 2 to 18 years of clinical nursing experience (median 6 years). All head nurses evaluated by subjects were female; 166 (52.5%) had junior profession titles, and 150 (47.5%) had senior profession titles. The mean age of head nurses was 41.3 ± 7.8. The head nurses worked in the leadership position for 2 to 30 years (median 8 years). The subjects spent 291 ± 13.3 s filling out the questionnaire. The item E5 '*The head nurse has been organizing training on nursing research knowledge and skills*' had the lowest average score (1.8 ± 1.5), while the item E4 '*The head nurse has been focusing on training nurses with willingness to conduct nursing research*.' had the highest average score (3.0 ± 0.9). The dimensions with the lowest and highest average scores were 'foresight' (2.5 ± 1.1) and 'inspiring' (2.6 ± 0.9; Appendix S3).

### 4.2 | Results of reliability evaluation

The Cronbach's α coefficient values were 0.902, 0.856, 0.936, 0.940, 0.832 and 0.966 for the 5 dimensions and the total scale, respectively. The Guttman Split-Half Coefficient values were 0.932, 0.877, 0.924, 0.915, 0.916 and 0.933 for the 5 dimensions and the total scale, respectively. The test–retest reliability was 0.927.

### 4.3 | Result of validity evaluation

#### 4.3.1 | The content validity of HNRLS

The average evaluation scores on items were 3.4 ± 0.8 to 4.0. The coefficients of variation were 0.000–0.178. The I-CVI of 15 items was 0.85–1.00, and the S-CVI was 0.95 (Appendix S4).

#### 4.3.2 | Structural validity of HNRLS

According to the CFA, the $\chi^2$/df = 1.570, RMSE = 0.076, GFI = 0.863, CFI = 0.972 and NFI = 0.928, indicating that the model fit was acceptable. The factor loadings were all accepted (>0.4; Table 2).

#### 4.3.3 | Convergent validity of HNRLS

The AVE of 5 dimensions was >0.5, and the CR was >0.7, indicating that the scale had good convergent validity (Table 3).

#### 4.3.4 | Discriminant validity (DV) of HNRLS

The results showed that the square root of the AVE of the 5 dimensions was greater than the absolute value of the correlation coefficient between them and other dimensions, which indicated that the scale had good DV (Table 4).

## 5 | DISCUSSIONS

With the gradual popularization of higher nursing education in China, the academic level of clinical nurses has significantly improved as

TABLE 2 Results of CFA

| Dimension | Item | Coef. | Std. Error | z (CR) | p | Std. Estimate |
|---|---|---|---|---|---|---|
| Foresight | A1 | 1.000 | – | – | – | 0.723 |
| | A2 | 1.335 | 0.141 | 9.458 | <0.001 | 0.936 |
| | A3 | 1.346 | 0.140 | 9.645 | <0.001 | 0.959 |
| Inspiring | B1 | 1.000 | – | – | – | 0.772 |
| | B3 | 1.631 | 0.180 | 9.080 | <0.001 | 0.832 |
| | B5 | 1.463 | 0.152 | 9.605 | <0.001 | 0.870 |
| Influence | C2 | 1.000 | – | – | – | 0.941 |
| | C3 | 1.054 | 0.060 | 17.585 | <0.001 | 0.922 |
| | C5 | 0.984 | 0.062 | 15.959 | <0.001 | 0.897 |
| Decisiveness | D1 | 1.000 | – | – | – | 0.954 |
| | D2 | 1.092 | 0.043 | 25.549 | <0.001 | 0.983 |
| | D3 | 1.088 | 0.083 | 13.172 | <0.001 | 0.827 |
| Control | E4 | 1.000 | – | – | – | 0.646 |
| | E5 | 2.304 | 0.320 | 7.205 | <0.001 | 0.875 |
| | E6 | 1.959 | 0.272 | 7.207 | <0.001 | 0.876 |

Abbreviation: CFA, confirmatory factor analysis.

TABLE 3 AVE and CR

| Factor | AVE | CR |
|---|---|---|
| Factor1 | 0.769 | 0.908 |
| Factor2 | 0.684 | 0.866 |
| Factor3 | 0.838 | 0.939 |
| Factor4 | 0.862 | 0.949 |
| Factor5 | 0.674 | 0.860 |

Abbreviations: AVE, Average variance extract; CR, composite reliability.

TABLE 4 Pearson correlation coefficient and the square root of AVE

| | Factor1 | Factor2 | Factor3 | Factor4 | Factor5 |
|---|---|---|---|---|---|
| Factor1 | **0.879** | | | | |
| Factor2 | 0.774 | **0.844** | | | |
| Factor3 | 0.725 | 0.838 | **0.915** | | |
| Factor4 | 0.658 | 0.776 | 0.894 | **0.920** | |
| Factor5 | 0.707 | 0.783 | 0.81 | 0.782 | **0.852** |

*Note*: The values of bold font were the square root of AVE.
Abbreviation: AVE, Average variance extract.

the number of registered nurses with a master's degree or above increased from 0 in 2002 to 8000 in 2018 (Zhang et al., 2021). However, nurses with high academic backgrounds face substantial difficulties in conducting nursing research in the hospital, such as unsuitable job positions, busy clinical patient care, lack of foundation and poor communication with other researchers (Keke & Yuanli, 2021). Over the years, researchers have realized the importance of leadership in clinical nursing research (Bagheri & Akbari, 2018; Berger & Polivka, 2015; González-García et al., 2020), while quantitative studies are often inadequate, given the absence of an appropriate tool for measuring nursing research leadership. In this research, the HNRLS was developed and validated for evaluating the leadership shown by head nurses in clinical nursing research. Significant differences were observed between the HNRLS and previous tools, which assessed the leadership in patient care or evidence-based practice (Aarons et al., 2014; Hui et al., 2020; Quan et al., 2021), emphasizing the necessity of this scale.

In this study, a new tool with 15 items of 5 dimensions for evaluating the research leadership of head nurse was developed, which is the first tool that can be used to measure research leadership of head nurse and lays a foundation for further research on research leadership. The Likert's 5-grade scoring method (0–4) was adopted and the total score was between 0 and 60. The average score of items in each dimension was the dimension score (0–4). Highest scores mean more powerful research leadership of head nurse. The analysis of reliability and validity showed that this scale was appropriate for evaluating the nursing research leadership of head nurse.

The five dimensions were decided after an in-depth analysis of the connotation of the 'five-force model of leadership' and the item pool was established based on a semi-structured interview, literature review and brainstorming to ensure the comprehensiveness of the established scale. In addition to thorough theoretical analysis and strict methodology, the process of clinical nursing research in the real world was regarded as an important reference in building the contents of these items, such as the proposal of research ideas and the publication of achievements, which promoted the better representativeness of items for measuring the research leadership of head nurses, consistent with the content validated by 20 experts. The reliability was evaluated using Cronbach's α coefficient, half reliability and test–retest reliability. All of the coefficients of the total scale and the 5 dimensions were larger

than 0.8, indicating that the HNRLS has good internal consistency and yielded a good performance (Ting et al., 2021). The results of structural validation showed that each item had satisfactory factor loading in the predetermined dimensions, indicating that the scale structure was reasonable. What needs to be mentioned in particular was that even if the items in the 'influence' and 'decisiveness' dimensions with maximum loading were in the same factors, they were regarded as two different dimensions according to the 'five-force model of leadership' after argumentation of researchers in our team. We thought that although the factor loading belonged to the same common factor, it showed that the correlation between these items was large statistically, they represented different meanings in a professional sense. A satisfactory CV indicates that items measuring the same potential target belong to the same dimension (Hair et al., 2011). The results of CV analysis showed that the HNRLS performed well, suggesting that items designed for evaluating the same characteristic belonged to the same dimension from a statistical point of view. By contrast, the DV indicates that items measuring one dimension should not have high loading in another dimension (Hair et al., 2011). CFA showed that the DV of HNRLS yielded a good performance, indicating that the scale could effectively assess the different elements of nursing research leadership.

Our results substantiated the low research leadership of head nurses ($64.3 \pm 17.6$), indicating that clinical nurses perceived a lack of leadership in nursing research. The dimension with the lowest score was 'foresight' ($2.5 \pm 1.1$). It is well-established that a leader with excellent foresight can predict the future and agenda a blueprint based on a thorough understanding of the previous, current and potential situations of this profession (Bishop & Hines, 2012). The low scores in 'foresight' meant that the head nurses had an inadequate understanding of the development, value and importance of clinical nursing research, which accounted for their inability to design studies in their departments. 'Foresight' is the most important characteristic in attracting followers (Research Group of Science and Technology Leadership of the Chinese Academy of Sciences, 2006c). Head nurses with low foresight often face difficulty enticing clinical nurses to participate in research activities. Moreover, the 'inspiring' dimension yielded the highest score in this study ($2.6 \pm 1.0$). It is widely acknowledged that outstanding leaders do not impose the system or rules on their staff but set a good example through their accomplishments to foster employees to make efforts and achieve organizational goals consciously (Research Group of Science and Technology Leadership of the Chinese Academy of Sciences, 2006e). The items in 'inspiring' included the knowledge, skill, achievement and behaviours of head nurses in nursing research, which reflect the connotation of inspiring. The highest score was observed for 'inspiring', given the rich research experience accumulated over the years as a clinical nurse until becoming a head nurse. Overall, clinical nurses perceive a lack of research leadership from head nurses, emphasizing the need for more efforts to be made in the future to enhance clinical nursing research.

### 5.1 | Limitations

The cross-sectional survey in this study was conducted only in a province in Central China, and the results cannot be generalized to research leadership of head nurses in China. A national norm must be established in the future, and its reliability and validity must be assessed in larger studies.

## 6 | CONCLUSIONS

In conclusion, an HNRLS consisting of 15 items from 5 dimensions (foresight, inspiring, influence, decisiveness and control) was developed to evaluate the research leadership of head nurses. The reliability and the validity were satisfactory, including the content, structural, convergent, discriminant validity, internal consistency reliability, half reliability and test–retest reliability. This study established a specific and reliable tool for future quantitative studies on nursing research leadership. Head nurse research leadership is inadequate in Henan province in China, especially in the foresight dimension. Hospital boards should undertake measures to strengthen the research leadership of head nurses, such as research leadership training and implementing a performance appraisal system on research leadership.

### 6.1 | Implications for nursing management

This research offered a new tool to assess the research leadership, which laid a foundation for further research on nursing research leadership and reminded nursing managers to strengthen the training and application of their research leadership and lead nurses with research ability to carry out nursing research to promote the construction and discipline development of nursing.

#### AUTHOR CONTRIBUTIONS

Guo Yuanli and Ma Keke made huge contributions to conception and design, or analysis and interpretation of data. Guo Lina, Dong Xiaofang, Yang Caixia, Wang Min, Gao Huanhuan and Lv Peihua made efforts on acquisition of data. Guo Yuanli and Ma Keke drafted the article and revised it critically for important intellectual content.

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#### CONFLICT OF INTEREST STATEMENT

There was no conflict of interest.

## DATA AVAILABILITY STATEMENT

The data relating to the current study are available from the corresponding author (M-KK) upon reasonable request.

## ETHICAL APPROVAL STATEMENT

This study was approved by the ethics committee of the First Affiliated Hospital of Zhengzhou University (2020-KS-HNSR071).

## ORCID

*Keke Ma* https://orcid.org/0000-0002-1727-4572
*Lina Guo* https://orcid.org/0000-0001-9843-6627

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## SUPPORTING INFORMATION

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